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ABSTRACT

The analogy of the leaky pipeline, the notion of women leaving or failing to choose science in droves, is represented frequently by researchers and scientists. "If the structural and cultural causes for the leakages are ignored, attempts at increasing the representation of women at various pipeline segments may fall short" (G. Sonnert, 1999). This paper extends this research perspective to women engineering students, considering little research has been conducted with women graduate students, particularly in relation to the reasons why they have continued their studies and their level of satisfaction with their career and lives. Moreover, R. Driver (1995) asserts "is a social dimension to the construction of scientific knowledge... which is constructed and transmitted through the culture and social institutions of science." The paper questions whether learning can take place if an individual does not participate fully in this sociocultural environment. The purpose of this research was to understand how sociocultural influences affect women's choices to participate in science. Three women from Canadian universities enrolled in the Master's in electrical engineering program were chosen as sample subjects. Qualitative interview data were collected using a multiple case study approach and narrative life histories were recorded. Appended are Themes-Findings from Women Master's in Engineering Interviews and tables of data from the study. (Contains 32 references.) (Author/BT)

Becoming a Woman Engineer in the Community of Practice: Validity and Value in Engineering-Education Research.

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BECOMING A WOMAN ENGINEER IN THE COMMUNITY OF PRACTICE: Validity and Value in Engineering-Education Research

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Abstract

The analogy of the 'leaky pipeline', that is the notion of women leaving or failing to choose science in droves is represented frequently by researchers and scientists (McIlwee and Robinson, 1992; Pattatucci, 1998; Sonnert, 1999; Sonnert and Holton, 1995). "If the structural and cultural causes for the leakages are ignored, attempts at increasing the representation of women at various pipeline segments may fall short"(Sonnert, 1999, p.39). I have now extended this research perspective to women engineering students as little research has been conducted with women graduate students especially in relation to the reasons why they have continued their studies, and their level of satisfaction with their career and lives (Frize, 1998). Moreover, Driver (1995) asserts that there "is a social dimension to the construction of scientific knowledge...which is constructed and transmitted through the culture and social institutions of science" (p. 395). If one does not participate fully in this sociocultural environment can learning take place? The purpose of this research is to understand how sociocultural influences affect women's choices to participate in science.

Key Words: Women, graduate, engineering, sociocultural, participation, choices.

Introduction

The analogy of the 'leaky pipeline', that is, the notion of women leaving or failing to choose science in droves is represented frequently by researchers and scientists (McIlwee and Robinson, 1992; Pattatucci, 1998; Sonnert, 1999; Sonnert and Holton, 1995). "If the structural and cultural causes for the leakages are ignored, attempts at increasing the representation of women at various pipeline segments may fall short" (Sonnert, 1999, p.39). Women face many obstacles in their academic careers as surmised in the literature but there is a gap in the research with regards to their perceptions of science. In my previous study examining the family, home, and school environment's influence on gifted girls' perceptions of choice to take extracurricular science classes, it was found that the 'broader environment' or the sociocultural influences had greatly impacted pre-adolescent gifted girls' choices to pursue extracurricular science classes. The objective of the present study is to understand how sociocultural influences affect women's choices to participate in science.

This research perspective is now extended to women engineering students. Even women who choose to take science at the university level "do not report gains as high as male students in the science, technology, and quantitative skills areas (Drew & Work, 1998). The field of engineering was chosen since it is still considered as having the lowest rate of female enrollment (Association of Universities and Colleges of Canada, 1995). The Canadian Council of Professional Engineers and the Canadian Engineering Resources Board (2000) report that the percentage of women majoring in graduate engineering programs compared to men in Canadian universities is 26. In addition, the same source reports 15.8 per cent of doctoral degrees and 32 per cent of masters degrees awarded in engineering to be to women. These percentages have shown an increase compared to previous years although the actual numbers are still small. While the numbers of graduate women enrolled have improved, the numbers of men have decreased.

Focused Literature Review

The findings of McIlwee and Robinson (1992) are far reaching. Women reported academic excellence in math and science as the most important reason for their engineering selection, followed by the profession being a practical choice, and being encouraged by someone to take this engineering option seriously. Women tended to select this university-major during their second or third year. Based on the women's successes in math and

science, they were fortunately prepared to switch to an engineering program. McIlwee and Robinson (1992) posited that while in university, both men and women shared the structural position of powerlessness imposed by the culture of the institution and the engineering professors. The 'culture of engineering', in both the academic and workplace settings, along with the women's family lives all involved the complex dialectic of structure and gender role, power relations and interactional resources that placed the women at a disadvantage.

More specifically, girls and women are placed in inferior positions in discussion with males. The later seldom give females a chance to talk, regard what they say as important, or consider women as equal participants in the discussion (Bell, 1989; Guzetti & Williams, 1996; Leroux, 1997). Bernstein and Gilligan (1990) believe girls think fairness and listening are intimately related concepts. Furthermore, Cherryholmes (1988) thinks there are hidden rules that govern discourse, establishing who can speak, when, and with what authority. It is not necessarily what is being said, but who is doing the talking that reflects the 'power' in a relationship (Guzzetti & Williams, 1996). The acknowledgement of power or validity of knowledge has been given the term "positionality" (Davies & Harre, 2000; Maher & Thompson-Tetreault, 1992). Tobin and Garrett (1987) believe that the tendency for men to achieve more than women in science results from greater opportunities to engage in academic activities, like discussions.

Why is discussion so important in the learning process? Alvermann and Hynd (1989) posit that depriving females of discussion is especially harmful in science because it is important to discuss ideas when students' theories are contradicted by scientific thought. Discourse and narrative are described as a mode of thinking, as a structure for organizing our knowledge, and as a vehicle in the process of science education (Bruner, 1996). Moreover, Bereiter (1994) asserts that this is a time where the belief of 'objective truth' has been replaced by an awareness of contextual influences, both cultural and historical. The only way to move scientific discourse forward is for students to experience an apprenticeship into this field, "moving from peripheral to more skillful and central participation" (Wells, 1999, p.219).

How are these social norms embedded in our language? Remlinger (1995) examined language, gender, and sexuality within the faculty of engineering at Michigan Technological University. Ethnographic data illustrated how and why the everyday talking and writing of university students reveals attitudes, values, and beliefs about gender and sexuality. Differential treatment based on sex, gender, and sexual practices limited the women's access to the same education as the dominant male engineering students. These limitations often occurred through "constraints on meanings and through events and activities that center on androcentric and heterosexual ideals of romance and relationships, and therefore, through the exclusion from the participation in and constitution of the campus culture for those students not meeting these ideal standards" (p. 177). Moreover, the apparent approval through inaction conveyed to students that resistance to these normative notions is ignored or silenced.

The following research questions guided this study: 1) What sociocultural influences affect female Ph.D. students' decision to participate in engineering? 2) From the perspective of female Ph.D. students, how does "non/participation" in the community of practice affect their learning? 3) How does the female Ph.D. students' participation in engineering affect their identity? 4) What do female Ph.D. students perceive as the "unofficial" ways of continuing the community of practice in the faculty of engineering.

Methods

The research questions were studied in light of learning as social participation. Wenger (1998) contends that "participation here refers not just to local events of engagement in certain activities with certain people, but to a more encompassing process of being active participants in the practices of social communities and constructing identities in relation to these communities" (p.4). Moreover, women master's candidates in the faculty of engineering can be seen as a community of practice with a unique identity. Driver (1995) asserts that there "is a social dimension to the construction of scientific knowledge...which is constructed and transmitted through the culture and social institutions of science" (p. 395). If one does not participate fully in this sociocultural environment can learning take place? It is important, therefore, to investigate how the context of the learning environment impacts on what is actually learned and how this affects the achievement of women in science.

On the basis of these statements, three women in the masters in electrical engineering were purposefully sampled from various Canadian universities. Qualitative interview data were collected using a multiple case study approach within multiple research sites (Merriam & Simpson, 1995; Yin, 1994). From a interpretist perspective, the analysis of the data consisted of five general analytical phases that include: (1) organizing the data, (2) generating themes, categories, and patterns, (3) testing emergent concepts, (4) exploring alternative explanations, and (5) composing the account (Marshall and Rossman, 1999). Mishler's (1996) 'case' life histories or stories make no claim for holistic descriptions of individual cases. In fact, the strength is in the applicability to a series of cases employing a comparative analysis of patterns. Moreover, the emphasis is on similarities and differences

among trajectories or structures (Mishler, 1996). In addition, life history analysis examined how the details of language get recruited (Gee, 1999; Mishler, 1999). Therefore, the participants' narrative accounts were grouped into idea units so that the parts make up the story as a whole.

Results

The narrative life histories' emergent themes were organized into three dimensions based on the conceptual framework (appendix A). The scope of this paper is such that not all salient themes could be fully discussed, therefore, an overview of my findings in relation to the research questions are provided (appendix B). Then, narratives used by the participants will illustrate the emergent themes and a more in-depth discussion of research question two will occur.

It is important to remember that this study was conducted from a sociocultural perspective that looks at the complex process of negotiating the tension of living between individuation and socialization through an interpretist frame. In addition, it must be recognized that as long as we try to separate the components of the sociocultural approach into 'cognition and setting', or 'individual and society' there will be confusion, unless we realize that these terms are only conceptual in a process of inquiry (Wertsch, 1995). The following elements were mentioned by all of the participants as being important and are displayed in the context that the participants described them.

Overview

Based on research question one, the themes were organized into two categories: environmental and individual. The sociocultural influences that affect female master's students' decisions to participate in engineering could not be easily isolated. Family support, role models, previous school experiences, living conditions, and peer influence were themes mentioned by the participants from an environmental perspective. In addition, reported 'aspects of the individual' included personality, motivation and fun, competence, love of math and challenges, and the perceived importance of their work.

The second research question addressed, "From the perspective of female Ph.D. students, how does "non/participation" in the community of practice affect their learning?" Although many similar terms were mentioned by all participants in relation to their learning and participation, their meanings differed for each, as well as how they affected their learning. These factors included: being the only girl, isolation, language, choosing not to speak, and cliques.

How does the female Ph.D. students' participation in engineering affect their identity? This third research question examined how the masters' women described themselves. The terms chosen to describe themselves in relation to their engineering experience was diverse: Odd, selfish, 'geeky', not a feminist. In addition, their narratives were analyzed using Gee (1999), examining how the details of language get recruited (appendix C).

Lastly, "What do female Ph.D. students perceive as the 'unofficial' ways of continuing the community of practice in the faculty of engineering". The components of the fourth research question consisted of initiation, iron-ring ceremony, engineering professors' treatment of students, sameness, attitude of superiority, male activities and co-op/workplace experience.

Second Research Question: In-depth

From the perspective of female Ph.D. students, how does "non/participation" in the community of practice affect their learning? Using the participant's narratives to illustrate common themes, the second research question was addressed in-depth. These include: Differential Treatment, Isolation, Only Girl, Language, Choosing Not to Speak, and Cliques. Different fonts were used in order to distinguish different participant's narratives.

Differential Treatment

Gender/sex affected the way in which the participants were treated by their engineering-peers. Although the treatment was not necessarily overt, it left these women confused. One participant spoke of being known and respected for her intelligence but because of her sex she was doubted for the first time.

> So every time we would get a midterm back, we would either have the same grade or it would be slightly higher than mine. So he was the person who challenged me the most. He was a really, really, smart guy. And I remember once he had missed a lecture with a bunch of his friends, and I met up with him and his buddies. I didn't know his buddies. And he asked me for my notes. I was giving him some notes and one of his buddies looked at me and basically one of his eyebrows went up. Like sizing me up—can I trust this person or not. And it was the first time anyone questioned me-I just remember it because of the way he looked at me; it hit

> me. And I was just-I didn't know them; no one would doubt me in the courses I've taken. This was the first time. And I [thought], why would I have to prove anything to you? And my friend said, "Oh no, no she can be trusted". After that -instant respect; just the fact that he knew me, and he respected me, I got instant respect from them...If it had been a man they didn't know, would they have been as skeptical? But it was the only time I had someone doubting me... He was kind of the bridge.

Being visible as a women in this situation brought into question her ability as an engineering student. Her intelligence being recognized by one of the 'smartest' guys acted as a bridge to her acceptance by his buddies. Similarly, another master's student affirmed working well with her boyfriend during her undergrad. She also thought 'they' worked well with the other guys in the group. Perhaps, her boyfriend also acted as a bridge. She states

> It was really interesting because we [boyfriend] just met and worked together on our courses and it went really well. We were a team in terms of working together so. That was in undergrad at the point where we were still taking core courses together. WE also worked with a group of guys, I don't want you to have the impression that I didn't like the men in my class because I really did. I thought they were wonderful; really very nice people. It was just that I would have liked to have some nice girlfriends in my class too.

Another graduate student found her visibility as a student was helpful in receiving employment from her university but it also appeared to have caused feeling of doubt. She stated

> Maybe I got the job at the university because I was a woman I don't know because they needed women. But I am sure they realized that I could do a good job as well.

This same participant also had the opportunity to become part of a 'start up company' with other students and her advisor. In this situation as well, her visibility was helpful. She recounted

> I became an employee of a company we are starting with my advisor and a few other master's students and it works well with technology and engineering...So it's the first year and it is a research company but that fits really well with what I want to do. I didn't want to work right away because I didn't want to work for a big company like I had done in my co-op.

Another participant also spoke of the advantage to visibility as a female student in engineering.

> Well because my professors would know me- well you are 'the girl' in the class-so when I went to get references for graduate school, they all knew me and when my fiancée went to get references they said, who are you?

Sometimes visibility was not always positive. One participant learned intimately what sexual harassment was and what it felt like as well as how to deal with again. Had she been seen as a 'powerful' person in the co-op workplace, perhaps this would not have happened. In fact, she reported this happening in another placement as well.

> I didn't want people to feel—"Oh we have to be careful around her. We can't touch her." And that is not it. And that was one of the things I had to get over about sexual harassment is to understand what it is. And it is a lot better to say something than to go through this. Even if people are more careful around you at least your mind is at peace and you are not afraid.

Isolation

All participants spoke of the perceived difference between their undergraduate and master's engineering program.

> Thinking back on that, I think I got a lot of help too [B.Eng.]. And maybe you don't realize how much help you are getting from other people. So, when I did go and do my masters degree it was a bit of a shock because it was so individual, you know you just do everything by yourself. You go home and work on the assignment and if you can't figure it out it's your problem.

Group work, whether organized or casual, is an important part of learning in the undergraduate program. In fact, the preference and importance for group work when learning new science concepts is supported by many researchers (Driver, 1995; Guzzetti & Williams, 1996; Hodson, 2001; McIlwee & Robinson, 1992; Wood, 2001).

Therefore, the reported isolation in graduate school adversely affects some women's learning so much so that one prominent winner of awards refused to consider pursing her PhD. She states

> I know my supervisor is talking about my PhD and things. And I won't do it, whether I am male or female or engineering whatever, like not now type of thing... a lot of it is because of the isolation. Even if you are doing research-especially in engineering, you are working essentially on something obscure and it is very specific so the only resource you really have is your supervisor. You know if you can find him sometimes. And well, my supervisor is very good he will make time for his graduate students. ... He is more the exception than the norm. It's very isolating, you have your own little project, you're got the corner of the lab and you are the only one working on it. And you have never done it and you kind of think I could drown and no one is ever going to notice.

Although isolation was perceived as a negative factor to learning in engineering, some participants also reported advantages. This engineer affirmed

> I think that is one thing that is not discussed much--that women in engineering can sort of get preferential treatment, definitely. I would say so because in some ways they are disadvantaged in terms of isolation; they are also advantaged in terms of being recognized and noticed. And you are more likely to be offered scholarships and all sorts of things that no one thinks of that as well.

The perception of preferential treatment for women in relation to engineering scholarships was troublesome for all participants. The wanted to be recognized for their intellectual ability not their sex/gender, although all accepted the scholarships they were offered.

> But I know in undergrad there were a lot of scholarships just for women-given to women to encourage women. And great for me because I got a bunch of them-they gave me a lot of support. But I have had some of my male friends say that it isn't fair. And it is true because they were really bright, got good grades, and there wasn't a scholarship they could get... Even if I had been in competition with them [men], I would have ended up having a higher average, but the point was that we weren't even in competition. Well, I don't know if men would resent women because of that? Like they don't have that attitude but I could see how that could create clashes. Like it is not meant to but I can see how it could.

Only Girl

Being one of just a few women in the class or program was problematic for most of the participants. In fact, sex/gender was the only prerequisite for group work for one participant. She asserted

> I would say that it was really hard through my undergraduate degree to be one of the only girls. Except for one, she was the only other girl that was there. We never spoke to each other after graduation; we just went our separate ways, we have never talked. But for four years, we sat together every day and did all of our work together. But it was just very hard because the guys in my class, you know, they would be going out on the weekends and stuff. There was never the idea that they would invite me because-"she" is someone we work with she is not a friend. Where they would like all make friends with each other. It was very hard because they would all work together in a group and I would work with 'THE' girl.

Gender/sex excluded this participant from working in groups with male students who would have, perhaps, added to the dialogic process of questioning science concepts (Alvermann & Hynd, 1989; Driver, 1995; Hodson, 2001; Patatucci, 1998; Wells, 1999). Moreover, this exclusion from dominant discourse and learning also affected her asking the professor to slow down and for clarification. She explicates

> If you are sitting in a class and there are 100 guys and 6 girls, and the girls say, "Could you slow down, I don't understand". You know, right away you feel like a stupid girl who doesn't get this stuff. So you are much more conspicuous. I never told them to slow down, and I probably should have you know; may be if I had given some feedback to the professors they would understand that I didn't know.

For another participant, being the 'only girl' made her feel comfortable. She explains

> My mom wasn't surprised at all when I picked engineering because she said you have always hung around with a bunch of guys-it will be just like home. I have never felt out of place, I know a lot of women have told me that they walk into an engineering building and they feel

> out of place. And I've never felt like that. Actually, I am the opposite, in a room full of women I feel very out of place.

Although this participant seems to have avoided discouraging experiences in engineering so far, it is probable that she may encounter them later due to her isolation and exclusion from "information and informal channels in graduate school" (Etzkowitz, Kemelgor, & Uzzi; 2000, p.16). While she did not feel out of place, she refused invitations to 'be one of the boys'.

Choosing Not To Speak.

Knowing when to speak or 'choosing their battles carefully' was described by all of the participants. One participant spoke of adapting, as a way of coping while in engineering. While some male students were publicly 'posturing' for dominance, asking questions they knew the answers to or proving their superiority through test scores, this participant did not participate. She asserts

> Another thing that was interesting was that I had to adapt. I thought they [male students] were all very nice to me but they weren't nice to my friends. And I think the reason is that I sort of adopted the attitude where I didn't challenge them, I just asked questions where I would say, "oh I didn't know that". I just sort of knew a lot of them had very large egos and just sort of went with it. I didn't make them feel that I was any kind of threat. So, I know a lot of guys would say, "what did you get, what was your mark"? And I just sort of stayed out of it all. --- I adapted. I never knew I was doing it. I never really changed. I know it sounds like a cop-out; I just never tried to challenge or fight with them about it or take on their attitudes. I just let them have it. Maybe the loneliness; you don't ever really let people know who you really are, but you can't make friends with them either. I think there are a lot of issues here that need to be looked at.

It appears that unknowingly, this participant became an imposter in order to ensure a less problematic presence in engineering class. In reflection, she posits that not letting the engineering students know of her abilities may have marginalized her and limited her interaction with them. It appears she had difficulty negotiating this learning environment. Another woman did not participate in the 'male-posturing' in engineering class but for a different reason. She states

> I have just found that people will think what they want. I mean if you have a guy in your class and he thinks women should not be in engineering, you could turn blue to convince him otherwise and you are never going to get through to him. So, it is basically-let him think what he wants, make sure he doesn't interfere with what you can do, [what] you want to do, and life goes on.

This participant realized that she could not change the attitudes of male-engineers who didn't want women in engineering. Although she added as long as their male-attitudes did not interfere with her learning. In fact she stated

> I have always been very independent, and pig-headed and strong willed apparently I always thought I looked kind ...fairly friendly. Even my friends were -if you want to be nice you are a friendly and open person [but] if you don't want to be messed with, you can look really mean. Like someone would be afraid to go up to you and I never knew that I did that or had that type of thing. Oh apparently I have this "don't mess with me attitude". I don't know if that saved me from a lot of grief in engineering or not-but I never had any. But apparently I have this side; I will bite your head off depending [on] what you do.

Conversely, one participant surmised that culture, in relation to gendered notions of who should speak and when, also affected participation and learning. She recounts

> Some people I didn't even know their names when I graduated because I had never talked to them. And there was a girl, in first year we had lab groups, and it turned out I was with 2 girls and a guy-a group of four. There was one girl in the group that would never speak to the guy. She would only speak to me if she had something to say to him. But she was from China or Hong Kong and didn't speak English very well, but also it was a cultural thing.

This finding is supported by previous research that suggests students who are women and belong to ethnic groups "often experience the greatest barriers to successful border crossing into the community of science" (Hodson, 2001, p.174).

Cliques/Language.

All students are members of many different social groupings; some long term and some very temporary. Many of these groupings are based on similarities and common interests. This woman explains

> In terms of, I mean people, its hard too because there weren't really any in my undergraduate program. I told you about the people I was in class with. There were 6 other girls but two of them spoke Chinese, and 2 of them were married and Arabic and much older, you know and I had nothing in common with them. It wasn't really that I could be friends with the other people. It was more cultural, and not that I was prejudice against them, but really they had no interest in being friends with me. It was really that we just didn't come together. So, I think the language is very, very big [factor]; a combination.

Similarly, another engineer recounts an incident where her female friend in engineering class belonged to an ethnic minority group. In her class, many who belong to this particular cultural group worked together. One male from this group insisted her friend come work with them. When her friend refused, this man accused the 'white' woman of being a racist and taking her friend away from their cultural group. The participant offered the explanation that the ethnic group wanted to protect and include her friend; but she was surprised at the accusation. While other participants in this study reported males not wanting to include them in working groups, it appears that sex/gender is forgiven and that the status of belonging to an ethnic minority group takes priority, at least within this group. Hodson (2001) explains this as 'personally satisfying participation' where each member of the social group has appropriate cultural knowledge.

One particularly important tool for sharing knowledge is that of language. One participant discusses

> My masters' degree was a huge challenge I would say because it was different working just totally independent on projects. And one of the biggest challenges was the fact that in my classes nobody spoke English...and it was the most isolating feeling in the whole world because I would come in and everybody would be speaking Chinese... Nobody talked to me the whole year in any of my classes and I just sat there and I felt that I was actually invisible- that there might have been a wall around me. And they couldn't see me because I was never acknowledged.

This noted importance of language is in keeping with Windschitl (1999). He states, "people construct knowledge in the presence of others who collectively constrain the environment with tools such as language" (Windschitl, 1999, p.190). Although sociocultural characteristics of groups are not identical, there must be sufficient shared qualities in order to make learning unproblematic (Hodson, 2001; Wells, 1999; Wenger, 1998).

Discussion

'Belonging' and 'participation' in relation to social and cultural groups became significant factors when examining learning in engineering. "The experiences of women scientists begin and end with the consequences of social exclusion in an activity that necessitates, perhaps demands, community" (Etzkowitz et al., 2000, p.16). Can acceptance and inclusion be mandated as proposed by government agencies [Industry Canada]? Does it help or hinder change? According to my participants, they do not think that mandatory inclusion is possible. Yet they call for changes in engineering education—it appears more difficult for some people of difference; sex being just one factor.

Do women engineers only allow themselves to see inequities after the passage through the academic culture of engineering? It seems the short but pungent (in some cases) experience in co-op allowed many to know what they didn't want to do; to choose graduate engineering as a way of ensuring more choice. We are shaped by both positive and negatively perceived experiences—perhaps both were necessary for them to fuel their movement forward through graduate engineering programs. One suggested way to examine the culture of power and change it to benefit students of 'difference' is to use reflexivity (Rodriguez, 1998). Moreover, this ability to reflect on one's understanding, and understand and control one's learning are methods of overcoming exclusion (Hodson, 2001).

These preliminary findings can be considered the catalyst for illuminating the multiple lens of difference, perhaps including men's perspectives in time as well. Moreover, my present research hopes to extend an understanding of the similarities and difference that exist for doctoral women in engineering.

References

Alvermann, D., & Hynd, C. (1989). The influence of text and discussion on the learning of counter-intuitive science concepts. Paper presented at annual meeting of the National Reading Conference, Austin, TX.

Association of Universities and Colleges of Canada (1995). Trends: The Canadian university profile.

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Bell, L. (1989). Something's wrong here and it's not me: Challenging the dilemmas that block girls' success. Journal for the Education of the Gifted, 12, (2), 118-130.

Bereiter, C. (1994). Implications of postmodernism for science, or, science as progressive discourse. Educational Psychologist, 29(1), 3-12.

Bernstein, E., & Gilligan, C. (1990). Unfairness and not listening: Converging themes in Emma Willard girls' development. In C. Gilligan, N. Lyons, & T. Hanmer (Eds.), Making connections: The relational world of adolescent girls at Emma Willard School. (pp. 147-161). Cambridge, MA: Harvard University Press.

Bell, L. (1989). Something's wrong here and it's not me: Challenging the dilemmas that block girls' success. Journal for the Education of the Gifted, 12, (2), 118-130.

Canadian Council of Professional Engineers (2000). Executive summary. http://www.ccpe.ca/ccpe.cfm?=execsumm

Canadian Engineering Resource Board (2000). University enrolment. http://www.ccpe.ca/ccpe.cfm?page=enrolment

Cherryholmes, C. (1988). Power and criticism: Poststructural investigation in education. New York: Teachers College Press.

Creswell, J. (1997). Qualitative inquiry and research design: Choosing among five traditions. California: Sage.

Davies, B. & Harre, R. (Jan. 2000). Positioning: The discursive production of selves. www.masseyac.nz/-Alock/position/position.htm

Drew, T., & Work, G. (1998). Gender-based differences in perception of experiences in higher education. The Journal of Higher Education, 69, (5), 542-455.

Driver, R. (1995). Constructivist approaches to science teaching. In Leslie Steffe and Jerry Gale (Eds.), Constructivism in education(pp. 271-286). Hillsdale, NJ: Lawrence Erlbaum.

Etzkowitz, H., Kemelgor, C., & Uzzi, B. (2000). Athena unbound: The advancement of women in science and technology. NY: Cambridge University Press.

Frize, M. (1998). Increasing the participation of women in science and engineering research. Paper presented at the APEC Expert's Meeting on Gender, Science, and Technology, Manila, Philippines.

Guzzetti, B., & Williams, W. (1996). Changing the pattern of gendered discussion: Lessons from science classrooms. Journal of Adolescent & Adult Literacy, 40(1), 38-47.

Hodson, D. (2001). Inclusion without assimilation: Science education from an anthropological and metacognitive perspective. Canadian Journal of Science, Mathematics, and Technology Education,1(2), 160-182.

Leroux, J. (1997). A secondary school journey: Programming for gifted students at a catholic high school in Canada. Gifted Education International, 12, 72-76.

Maher, F. & Thompson-Tetreault, M. (1992). Inside feminist classrooms: An ethnographic approach. New Directions For Teaching and Learning, 49, 57-74.

McIlwee, J.S. & Robinson, J.G. (1992). Women in engineering: Gender, power, and workplace culture. NY: SUNY.

Merriam, S.B., & Simpson, E.L. (1995). A guide to research for educators and trainers of adults. Malabar, FL: Krieger Publishing.

Mishler, E.G. (1999). Storylines: Craft artists' narratives of identity. MA: Harvard University Press.

Pattatucci, M. (1998). (Ed.) Women in science: Meeting career challenges. Thousand Oaks, CA: Sage Publications.

Remlinger, K.A. (1995). Production, resistance, and opposition: Students linguistically constituting ideologies of gender and sexuality. Unpublished doctoral thesis, Michigan Technological University, Michigan, USA.

Sonnert, G. (1999). Women in science and engineering: Advances, challenges, and solutions. In Cecily Cannan Selby (Ed.), Women in science and engineering: Choices for success (vol. 869, pp. 34-57). NY: Annals of New York Academy of Sciences.

Sonnert, G. & Holton, G. (1995). Gender differences in science careers: The project access study. NJ: Rutgers University Press.

Tobin, K., & Garrett, P. (1987). Gender related differences in science activities. Science Education, 71, (1), 91-103.

Wells, G. (1999). Dialogic inquiry: Towards a sociocultural practice and theory of education. NY: Cambridge University Press.

Wenger, E. (1998). Communities of Practice: Learning, meaning, and identity. NY: Cambridge University Press.

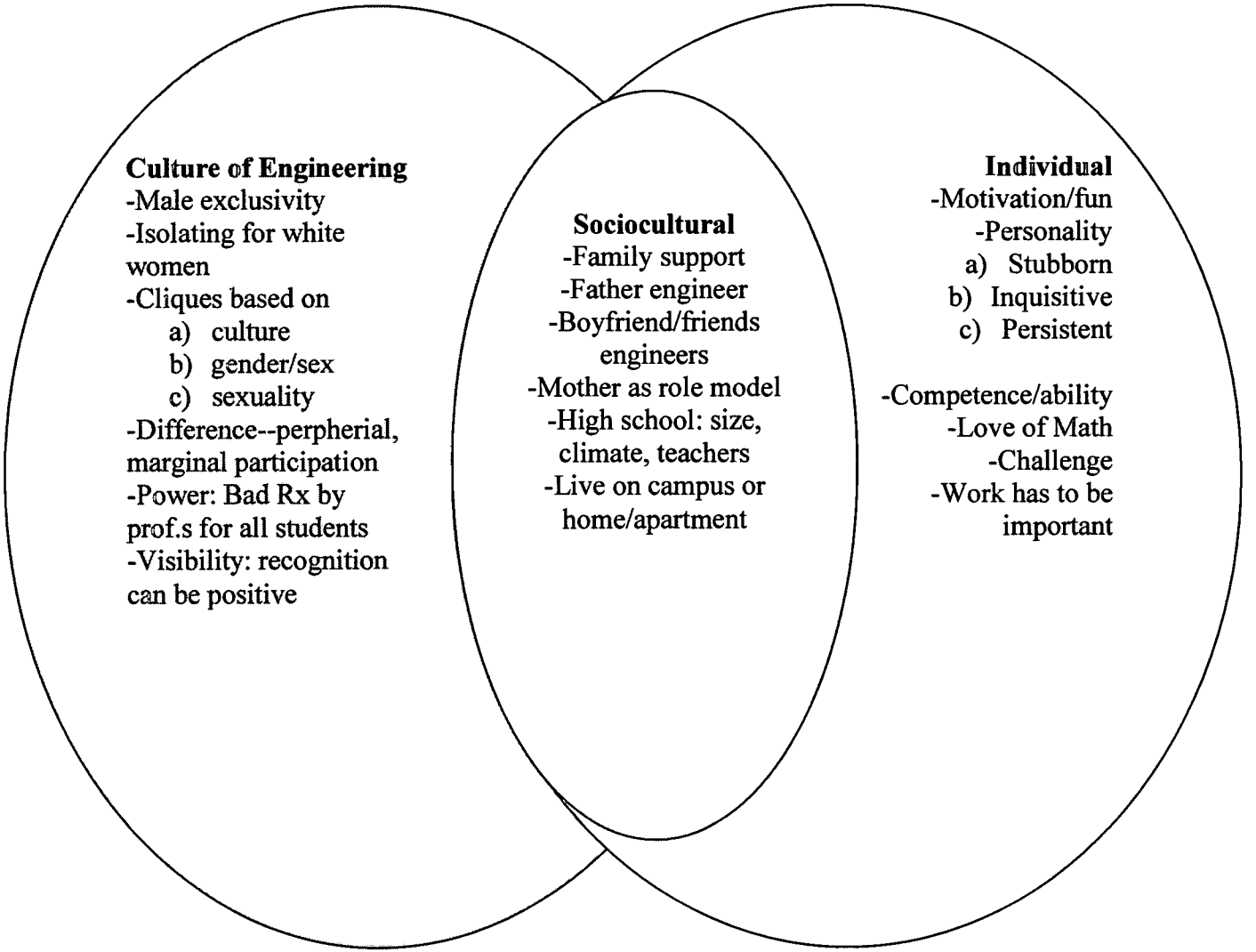
Windschitl, M. (1999). A vision educators can put into practice: Portraying the constructivist classroom as a cultural system. School Science & Mathematics, 99, 189-196.

Yin, R. (1994). Case study research: Design and method(2nd.ed.) Newbury Park, CA: Sage.

Wood, S. L. (2001). Perspectives of best practices for learning gender-inclusive science. Paper published in conference proceedings, Tenth International Gender and Science and Technology Conference, -Socially Responsible and Gender Inclusive Science and Technology, Copenhagen, Denmark.

Appendix A

Themes-Findings From Women Masters' in Engineering Interviews



RQ1 Sociocultural	Influences	RQ2: Non/participation	RQ3: Part. & Identity	RQ4: Cont. Comm Practice
Environmental	*Individual*			
Family support	Personality	Differential Treatment	1) Analyzed Gee (1999) Chart I statements	Initiation
Role models	Motivation	Only Girl	2) Diverse statements:	Iron-ring ceremony
Previous school experience	Fun	Isolation	Odd	Rx by professors
Living conditions	Competence	Language	Selfish	Sameness
Peer influence	Love of math &	Cliques	Geeky	Attitude of superiority
	Challenges	Choosing not to speak	Not a feminist	Male Activities
	Perceived importance Work			Co-op/workplace experience

Appendix B

S. Wood
AERA April 2002

Appendix C

Masters Women Data	Identity	Interview 1	Interview 2	Interview3	No.	Section
Gee (1999) Areas	Statements	381text units	290 text units	443 text units		Total
Cognitive	I think	35	60	10	105	225
	I thought	8	11	4	23	
	I know	1	8	22	31	
	I guess	22	8	36	66	
Affective	I love (d)	1	1	2	4	52
	I want	11	12	8	31	
	I like	5	6	2	13	
	I need	3	0	1	4	
State/Action	I do	1	3	2	6	320
	I do Not	31	34	72	137	
	I got	0	4	14	18	
	I went	1	6	15	22	
	I don't remember	6	1	2	9	
	I do remember	0	0	25	25	
	I did	5	4	7	16	
	I did Not	11	16	12	39	
	I talk	1	3	0	4	
	I tell (told)	2	1	0	3	
	I will	7	3	10	20	
	I ask	0	2	2	4	
	I said	6	4	7	17	
Ability/Constraint	I can't	3	4	8	15	29
	I can	3	3	4	10	
	I have to	2	0	2	4	
Achievement States	I challenge	0	0	0	0	0
	I want to	0	0	0	0	
Gilligan (1993)& Kerr (1994)	I am not sure	4	1	0	5	197
	I don't know	16	8	42	60	
	umh/ugh	2	2	69	73	
	pause	0	5	3	8	
	silence	0	0	5	5	
	laugh	31	2	13	46	
	Participant total	218	212	399	823	823

S. Wood, U of Ottawa
AERA April 2002

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